ACC HDLC/LAP-D Protocol User's Guide

Edition 4

HP 9000 EISA Computers

Manufacturing Part Number: Z7487-90006
E0400

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Preface

The HDLC/LAP-D Protocol Product is used in conjunction with Hewlett-Packard's Advanced Communications Controller (ACC) product. Specifically this protocol applies only to the E1/T1 4-port multiplexer cards (Z7300A etc.)

This manual applies to the ACC Protocols for Application Developers product.

This manual explains installing the HDLC/LAP-D protocol module and configuring it into the ACC product.

Publishing History

The Printing History below identifies the edition of this manual and any updates that are included. Periodically, update packages are distributed which contain replacement pages to be merged into the manual, including an updated copy of this printing history page. Also, the update may contain write-in instructions.

Each reprinting of this manual will incorporate all past updates; however, no new information will be added. Thus, the reprinted copy will be identical in content to prior printings of the same edition with its user-inserted update information. New editions of this manual will contain new information, as well as all updates.

Manual updates may be issued between editions to correct errors or document product changes. To ensure that you receive the updated or new editions, you should subscribe to the appropriate product support service. See your HP sales representative for details.

First Edition	January 1997.	Release B.02.30
Second Edition	June 1997	Release B.02.39 (HP-UX 10.10) Release B.02.40 (HP-UX 10.20)
Third Edition	October 1998	Release B.03.01 (HP-UX 11.0)
Fourth Edition	**April 2000**	**Release B.03.10 (HP-UX 11.0)**

Organization

This manual contains the following chapters and appendices:

Chapter 1	**Introduction** - presents an overview of the features provided by the HDLC/LAP-D Protocol product.
Chapter 2	**Software Installation and Verification** - describes how to install the protocol module software. It describes how to verify that the protocol software is correctly installed and is functional.
Chapter 3	**Using HDLC/LAP-D Protocol** - contains information about using the HDLC/LAP-D protocol
Chapter 4	**Protocol Specific Configuration** - contains HDLC/ LAP-D specific configuration information.
Appendix A	**Sample Configuration Files -** contains a listing of the sample configuration files provided with this product.

Related Documentation

The documentation available for the Multiprotocol ACC family of products includes the following hardware and software manuals:

Hardware Manuals

- *8 Channel HP-PB ACC Multiplexer Hardware Installation and Reference Manual*
- *8 Channel EISA ACC Multiplexer Hardware Installation and Reference Manual*
- *8 Channel PCI ACC Multiplexer Hardware Installation and Reference Manual*
- *2 Channel (HP-PB) ACC Multiplexer Hardware Installation and Reference Manual*
- *4-Chan. T1/E1 (HP-PB) ACC Multiplexer Hardware Installation and Reference Manual*

Software Manuals

- *ACC Installation and Configuration Guide*
- *ACC Utilities Reference Guide*
- *ACC Programmer's Reference Guide*
- *ACC Error Guide*
- *HDLC Frame Protocol User's Guide*
- *ACC X.25 Protocol User's Guide*
- *ACC X.25/ISDN Data Analyzer User's Guide*
- *ACC HDLC/LAP-B (ABM) Protocol User's Guide*
- *ACC HDLC/LAP-D Protocol User's Guide*
- *HDLC-NRM (SDLC) Protocol User's Guide*
- *X.25/ACC Installation and Configuration Guide*
- *X.25/ACC Update Guide*
- *X.25/9000 User's Guide*
- *X.25/9000 Programmer's Guide*

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1 Overview

Introduction

The HDLC/LAP-D Protocol product is the Data Link or Level 2 layer used in conjunction with the Advanced Communications Controller (ACC) product. This manual provides installation and configuration information that is specific to the HDLC/LAP-D protocol.

NOTE The ACC HDLC/LAP-D Protocol product currently runs only on the 4-channel E1/T1 Multiprotocol ACC card.

Product Features

The LAP-D (Link Access Procedure - D Channel) protocol is defined in ITU-T Recommendation Q.921.

Supported Devices

Any device which conforms to the published HDLC/LAP-D standards will be supported by this ZCOM HDLC/LAP-D implementation.

References

For information on installing the ACC product and how to start up the ACC Subsystem, refer to the *ACC Installation and Configuration Guide*.

For information on use of the ZCOM Programmatic Interface, refer to the *ACC Programmer's Reference Guide*.

For information on using the utilities related to the ACC products, refer to the *ACC Utilities Reference Guide*.

For information on error messages related to the ACC products, refer to the *ACC Error Guide*.

2 Software Installation and Verification

Introduction

The HDLC/LAP-D protocol is included in the ACC Developer Software Suite product. This chapter describes how to install the product using the *swinstall* utility. It also describes how to verify that the protocol has been successfully installed and is functional.

Software Removal

If a previous version of the HDLC/LAP-D protocol product is already on the HP-UX system, it should first be removed.

CAUTION It is very important to follow the instructions provided with the software that is currently installed in the system to shutdown and remove that software. This procedure may change between major releases of the product.

Step 1. Log in to the system as superuser.

Step 2. Terminate the ACC Mux Subsystem by typing:

```
% zmastrd kill
```

Step 3. Run *swremove* to remove the HDLC/LAP-D protocol product.

```
% swremove
```

NOTE The *swremove* will fail if any ACC daemon is still active. Terminate any active ACC daemon indicated in the log file and try again.

Any of the ACC related products can be removed by selecting them and then marking them for removal. (Both the terminal interface and the GUI interface for *swremove* behave the same; only the means for selecting items differs.)

Step 4. Select the HDLC/LAP-D protocol product (and any other items to be removed) in the “Software Selection Window” and mark for removal, using the “Mark for Remove” function under the “Actions” menu. When all items are marked, select the “Remove(analysis)” action.

Open “Logfile” to view running status of the removal process, and follow any screen prompts until the removal process is done.

Software Installation

Running Swinstall

The ACC software is read from the HP-UX Application CD-ROM, in superuser mode, using the *swinstall* utility. The steps are shown below.

Step 1. Log in to the system as “root”.

Step 2. Place the media in a local or remote CD-ROM drive.

Step 3. Run *swinstall*, which behaves the same in the GUI interface as for the terminal interface. When the “Specify Source” box opens, select “Source Depot Type” to “Local CDROM”, or for a remote CD-ROM driver, select for “Network Directory/CDROM” and set “Source Host Name...”. Select “OK”.

Step 4. Select the ACC Developer Software Suite product and any other ACC items to be installed, from the list of software bundles; open the “Actions” menu and select “Mark for Install”.

Step 5. When all items have been marked, select “Install (analysis)”; select “OK” and proceed.

The “Install (analysis)” window allows you to track summary progress of the installation process. Use the “Logfile” feature to display a detailed status, which is logged to */var/adm/sw/swagent.log*.

Product Identification

The **what** utility can be run on */opt/acc/<card-type>/lapd.zabs*. to show what version of the protocols is installed.

Installation Verification

A sample configuration file */opt/acc/cfg/lapd_4ch_sample.answ* file is provided with the ACC Developer Software Suite product. This sample file can be used to verify that the HDLC/LAP-D protocol module has been properly installed and is functional. Note that you need to customize this file, to reflect the location of the mux card(s) and to reflect the mux ports to be used. (The *lapd_4ch_sample.answ* file is shown in Appendix A , "Sample Configuration Files,".)

The steps in the verification process are listed below. It is assumed that the ACC Developer Software Suite product is installed on the system, and that there is at least one ACC Multiplexer card installed with cabling attached.

A loopback cable should be used to connect two of the ports on the multiplexer. For the configuration file provided, it is assumed that the first two ports of the mux card are connected with a loopback cable.

Using the HDLC/LAP-D Protocol Module

The *ACC Installation and Configuration Guide* contains the general procedure for configuring the network configuration file, and starting up the ACC subsystem with the new protocol and new configuration. Refer to Chapter 4 , "Protocol Specific Configuration," for HDLC/LAP-D specific configuration requirements when building the network configuration file.

Verification Procedure

The procedure described involves using the *ttgen*, *zmntr*, and *zterm* utilities. These utilities are described in the *ACC Utilities Reference Guide*.

Step 1. Modify the *Mux* definition statement in the */opt/acc/cfg/lapd_4ch_sample.answ* to reflect the location of the ACC Mux cards if necessary. (Refer to Chapter 4 , "Protocol Specific Configuration," for information on how to modify this statement.)

Step 2. The sample file only configures the first two ports of one mux card. If desired, expand the configuration file to include additional ports.

NOTE For the test described here, the ports that will be logically connected together must have one port configured as DTE, and the other as DCE.

Run *ttgen* on the .answ file.

```
% ttgen -o lapd_4ch_sample.answ lapd_4ch_sample.tmem
ttgen: END$  0 Disasters, 0 Errors, 0 Warnings
%
```

Step 3. Bring up the ZCOM subsystem:

```
% zmasterd cold /opt/acc/cfg/lapd_4ch_sample.tmem
```

Step 4. Monitor the log file:

It is suggested that the appropriate */var/opt/acc/log/*.tlog* file, e.g. *mon.tlog, tue.tlog*, etc. be monitored to make sure the ZCOM subsystem comes up. The following *zmlog* messages could be seen:

```
------------------------------------------------------------------------
Tue Jun 17 11:28:55 1998: zmlog: message logging resumed
------------------------------------------------------------------------

11:28:54 zmast 00101   Launched daemon zmlog, pid 1704.
11:28:54 zmast 00117   Zmasterd daemon start running ...
11:28:54 zmast 00101   Launched daemon zmon, pid 1705.
11:28:55 zmon  00002   Resource manager (Rev 1.32) for ZCOM 6.1.0.0
11:28:55 zmon  00003   Cold start with: lapd_4ch_sample.tmem
11:28:55 zmon  00100   Card 0 starting up ...
11:28:58 zmon  00110   Card 0 startup successful, card READY
11:28:58 zmon  00020   Cold start completed, ZCOM system ready
11:28:58 zmon  00004   Waiting for ZMON requests ...
11:28:58 zmast 00101   Launched daemon znode, pid 1726.
11:28:59 zcom  00165   Node 123 is now UP
```

Step 5. The *zmntr* utility can be used to display the state of the HDLC/LAP-D link:

```
% zmntr
ZMNTR> tt 600 601
 ZLU# Mx p:sc Terminal Description....   Rx.Mes Tx.Mes Errors E.Rate State......
 0600 00 0:01  LAP-D DCE                      0      0      0  0.00% Disabled
 0601 00 1:01  LAP-D DTE                      0      0      0  0.00% Disabled
 **** ** ** Message totals                    0      0      0 NaN  % ********
ZMNTR> ex
```

Step 6. The link can now be enabled and brought up using the *zterm* utility:

```
% zterm
11:34:46 ZCOM Interactive command utility
11:34:46 Primary ZLU is 1001
ZTERM> rc 600 601
ZTERM> cn 600 601 en
ZTERM> cn 600 601 ac
ZTERM> ex
%
```

Step 7. The *zmntr* utility can be used to observe the state of the link:

```
%  zmntr
ZMNTR> tt 600 601
 ZLU# Mx p:sc Terminal Description...  Rx.Mes Tx.Mes Errors E.Rate State.......
 0600 00 0:01  LAP-D DCE                    0      0      0  0.00% Up
 0601 00 1:01  LAP-D DTE                    0      0      0  0.00% Up
 **** ** ** Message totals                  0      0      0 NaN  % ********
ZMNTR> ex
```

Step 8. With the *zterm* utility set as a receiver, test messages are sent from the ZLUs:

```
% zterm
11:46:56 ZCOM Interactive command utility
11:46:56 Primary ZLU is 1001
ZTERM> rc 600 601
ZTERM> tx 600 50 0 2 2
11:47:14 TX test complete!!!
ZTERM>
```

NOTE For this example two fifty-byte messages are transmitted from DCE to DTE.

Step 9. The received data can now be displayed:

```
ZTERM> rx list
11:49:49 Msg from tmnl ZLU#00601(00123) len    50 No error detected
 Lcn .00. .01. .02. .03. .04. .05. .06. .07. .08. .09.  ASCII.....ASCII.....
 000 5A74 3031 3739 3800 206D 6573 7361 6765 206E 6F2E  Zt01798  message no.
 010 2030 3030 3031 206C 656E 6774 6820 2020 2035 3024   00001 length    50$
 020 6F70 7172 7374 7576 7758                          opqrstuvwX

11:49:49 Msg from tmnl ZLU#00601(00123) len    50 No error detected
 Lcn .00. .01. .02. .03. .04. .05. .06. .07. .08. .09.  ASCII.....ASCII.....
 000 5A74 3031 3739 3800 206D 6573 7361 6765 206E 6F2E  Zt01798  message no.
 010 2030 3030 3032 206C 656E 6774 6820 2020 2035 3024   00002 length    50$
 020 6F70 7172 7374 7576 7758                          opqrstuvwX

<CNTRL-C>


11:50:36 Error on ZREAD: Interrupt occurs while waiting
11:50:36 Messages received         2,    Messages sent            0
11:50:36 Elapsed time secs        47,    Messages/sec             0
11:50:36 Data in KBytes            0,    Data rate (KB/s)         0
11:50:36 Sys CPU   0%, User CPU   0%,    Total CPU   0%
11:50:36 Mux   0 utilization      1%
ZTERM>
```

3 Using HDLC/LAP-D Protocol

Introduction

For a complete description of the communication formats the reader is referred to the standards documents mentioned at the start of this manual.

Each unit transmitted over an HDLC/LAP-D link is a “frame”. A frame has a header and a trailing CRC, is preceded and followed by a flag byte (binary 01111110), and may include an “I” (information) field as well. Frames may be information transfer, supervisory or unnumbered. The headers of information transfer and supervisory frames contain frame-level sequence numbers.

The maximum length of the (received) I-field must be established and agreed upon for any given HDLC/LAP-D link, so that buffering requirements may be met and appropriate timer values set. The ACC HDLC/LAP-D implementation will allow agreed maximum I-frame sizes of up to 16,383 bytes. For further detail, see Chapter 4 , “Protocol Specific Configuration.”

General Protocol Processing

Application Message Headers

All application data is transmitted (or received) as the I-field of either an information transfer frame or an unnumbered information frame. All headers and/or trailers are supplied by the protocol for outgoing messages and removed by the protocol for incoming messages. Only the I-field data to be transferred is dealt with by the application program, which need not even be aware that HDLC/LAP-D is being used for the communications.

Unnumbered Information Frames

HDLC/LAP-D can transmit and receive I-fields within either numbered information frames (I frames) or unnumbered information frames (UI frames). To transmit and receive UI frames, a terminal must be defined that has the UI bit set in the terminal's Poll Word; see “Poll Word” on page 47. All data sent to a UI terminal will be sent on the configured SAPI/TEI as a UI frame. When a UI frame is received, and there is an enabled UI terminal configured with a matching SAPI/TEI, the I-field of the UI frame will be sent to that UI terminal.

To transmit and receive I frames, multiple frame acknowledged operation must be established. Multiple frame acknowledged operation is handled by terminals configured without the UI bit set. These terminals handle all frames that are not associated with a configured and enabled UI terminal.

The UI and non-UI terminals are capable of coexisting with each other on a given SAPI/TEI as well as being able to independently exist. In other words, there may be no terminals, just a UI terminal, just a non-UI terminal or both a UI and non-UI terminal configured on a single SAPI/TEI.

Timeout Processing

Frame timeouts are set in the Select configuration word. The T200 timer defines the period within which a response to a Command frame must be received across the HDLC/LAP-D link. Should this timer expire before the expected response is received, then the Command frame will be re-transmitted up to a pre-determined maximum number of times. The maximum number of re-transmissions (N200) is also set by the Select configuration word. If the timer expires on that number of successive occasions, then the LAP-D link will be reset.

An additional timer, known as T203 is used to control the maximum amount of time that can pass without any frames being exchanged. It is configured in the first Option word and defaults to being T200*N200*100/16.

Request Specific Processing

Terminal Enable/Disable Requests

Enabling a non-UI terminal causes the protocol to attempt to enter multiple frame acknowledged operation (the state that allows Information frames to be exchanged). Disabling a terminal causes the non-UI terminal to exit multiple frame acknowledged operation. A newly created terminal is initially disabled. Enabling/disabling UI terminals simply allows/disallows the transmission and reception of UI frames. These requests cause unsolicited status messages to be sent by the protocol. For details regarding status codes and messages, see “Status and Error Messages”, later in this chapter.

Terminal Activate/Deactivate Requests

Activating a non-UI terminal allows the terminal to receive data (the protocol sends Receive Ready frames to indicate it is ready to receive Information frames). Deactivating the terminal prevents the terminal from receiving data (the protocol send Receive Not Ready frames). A newly created terminal is initially deactivated. For UI terminals, these requests only toggle the terminal activated flag; they do not affect the reception of data.

Write (Transmit) Requests

The data sent to the protocol via a write request becomes the information field within an I-frame or UI-frame.

The terminal must be enabled before any write requests may be sent to the terminal. In addition, for an Information frame to be sent, multiple frame acknowledged operation must have been established.

Control Requests

All control writes to this protocol share a common format. The first four bytes are defined as a header:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Control Code								Control Length							
Packet Length															

Control Code — Defines the action to be taken by this request.

Control Length — The length of the data for this control request. This data immediately follows the header.

Packet Length — Some protocols allow packet data (data to be transmitted over the wire) to be passed to a control write following the control request data. For this protocol, these two bytes must be zero because the protocol does not allow packet data within a control write.

This protocol allows the following Control Codes:

5 `CW_STATS` `Send ST25L2STAT status message`

This control write triggers the protocol to send a `ST25L2STAT` status message. For the format of this message, see the section on “Status and Error Messages”. Control length must be zero.

6 `CW_REVCODE` `Send ST25REVCD status message`

This control write triggers the protocol to send a `ST25REVCD` status message. For the format of this message, see the section on “Status and Error Messages”. Control length must be zero.

7 `CW_TIMERS` `Set timers`

This request is only allowed for non-UI terminals. The protocol's timers may be changed from their configured values using this control write. This request should be used with caution because the values configured with this request will not be restored if the card is reset by ZCOM.

The control request data consists of three pairs of bytes. Each pair of bytes consists of a Resolution and a Value. The legal values for Resolution are as follows: 0 = don't set, 1 = 10msec, 2 = 100msec, 3 = 1sec, 4 = 10sec.

Note that these values are different from the values used for the resolutions when configuring a terminal. The Values are used directly. A zero Value will disable the timer if the resolution is non-zero.

The first pair of bytes applies to T200, the second pair is ignored (should be set to zero) and the third pair apply to T203:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
T200 Resolution (0-4)								T200 Value (0-255)							
0															
T203 Resolution (0-4)								T203 Value (0-255)							

Received Data

When I-frames or UI-frames are received, the information field is sent to the associated ZLU.

Status and Error Messages

HDLC/LAP-D produces a range of buffer status codes and unsolicited status messages, apart from the standard communications statuses described elsewhere in the ACC documentation. In the following descriptions, the statuses marked with a dagger (†) are not generated by UI terminals. The defines for these status codes are located in */usr/include/zcom/zcomstatus.h* and */usr/include/zcom/zx25status.h*.

Terminal Request Status Codes

The following statuses are returned in response to a request to create, destroy, enable, disable, activate or deactivate a terminal. Although these are a part of the standard status set, they are not used by all protocols, and have a particular significance within HDLC/LAP-D.

0	TM_OK	No error detected
		The request was successfully processed. In the case of enabling or disabling the terminal, this does not mean that the link has been established or disconnected. The link status is reported via unsolicited status messages.
1	TM_MUST_DSBL	Terminal must be disabled
		This status code is returned in response to a terminal delete request. Before deleting a terminal, it must be disabled and the ST25DSBL unsolicited status message must have been received.
12	TM_PROT_REJ	Protocol detected error
		TM_PROT_REJ is returned in response to a terminal enable request when the configuration specified by the poll, select and option words is invalid. In addition to returning TM_PROT_REJ, the protocol generates a ST25ENF unsolicited status message. For configuration information, Chapter 4 , “Protocol Specific Configuration.” Another possible, although unlikely, cause for TM_PROT_REJ is that an error occurred when the protocol attempted to setup a group of LAP-D terminals. In this case, the ST25ENF unsolicited status message will not be generated.

14	TM_TABLE_SIZE	Protocol table sizes too small

The configured terminal table size is too small to allow LAP-D to run. This status is returned in response to a terminal creation request.

Unsolicited Status Messages

This section describe the unsolicited status messages which may be received on the ZLU which is set as the receiver for a terminal using this protocol. The status codes received may or may not have bit 7 set. Bit 7 is the down bit (masked by IO_DOWN_MASK). The down bit is used as an indicator of the link status. When an error occurs on the link or the link is enabled after being disabled, the protocol attempts to enter multiple frame acknowledged operation. Until the attempt succeeds or fails, the down bit is clear (i.e. the terminal is considered to be up until proven otherwise). If the attempt subsequently fails, the down bit is set; otherwise the down bit left cleared. The following status messages are generated in response to terminal enable and disable requests:

0	IO_OK	No error detected

This status message is generated in response to a terminal enable request after multiple frame acknowledged operation is established. Note that the down bit will always be clear.

41	IO_ALRDY_ENBL	Terminal already enabled

This status message is generated in response to a terminal enable request when the terminal is already enabled and the protocol is not currently trying to establish multiple frame acknowledged operation. If the protocol is currently trying to establish multiple frame acknowledged operation, this status message will not be sent. Instead, either a ST25ENBL with the down bit set or an IO_OK status message will be sent.

42	IO_ALRDY_DSBL	Terminal already disabled

This status message is generated in response to a terminal disable request when the terminal is already disabled. The down bit will always be set.

64	ST25ENBL†	`Link NOT established on ENABLE` This status message is generated in response to a terminal enable request after it is determined that multiple frame acknowledged operation can not be established. The down bit will always be set.
65	ST25DSBL	`Link disconnected on DISABLE` This status message is generated in response to a terminal disable request after multiple frame acknowledged operation has terminated. The down bit will always be set.
77	ST25ENF	`ENABLE failed - bad config` This status message is generated in response to a terminal enable request when the terminal's configuration is invalid. The down bit will always be set.

The following status messages are sent after an error occurs when the link is in multiple frame acknowledged operation. The error conditions include cable faults, inability to receive acknowledgment of transmitted frames or receiving frames that are inconsistent with multiple frame acknowledged operation. When one of these error conditions occur, the protocol attempts to reestablish multiple frame acknowledged operation. *After* the attempt has either succeeded or failed, the unsolicited status message that reflects the original error condition is sent. If the attempt fails, the link is considered disconnected and the down bit will be set in the status; otherwise the link has only been reset and the down bit will be clear.

66	ST25XDCD	`Link disc. on loss of carrier` The card is no longer receiving the required communications signals. This can be caused by incorrect port configuration or disconnected/faulty cabling.
68	ST25RTRY†	`Exceeded retransmit limit` A frame was transmitted N200 times without receiving an acknowledgment from the remote.

69	ST25TXFR†	`Reset/Disc. due to transmitted FRMR` An unrecognized frame was received by the protocol; this causes LAP-D to reset the link by sending a SABME. For consistent error handling between LAP-D and LAP-B (which sends a FRMR instead of a SABME), the protocol sends this status message. The data buffer contains the information field of the FRMR that LAP-B would send.
70	ST25RXFR†	`Reset/Disc. due to received FRMR` A frame reject response was received. A copy of the received FRMR's information field is in the data buffer of the unsolicited status message.
71	ST25RXDM†	`Reset/Disc. due to received DM` The protocol received a Disconnected Mode response.
72	ST25RXSA†	`Reset/Disc. due to recvd SABM/SABME` A Set Asynchronous Balanced Mode Extended command was received by the protocol.
73	ST25RXDI†	`Reset/Disc. due to received DISC` The protocol received a DISConnect command.
74	ST25RXUA†	`Reset/Disc. due to received UA` An Unnumbered Acknowledgment response was received by the protocol when the protocol had not solicited a UA.
75	ST25RUFR†	`Reset/Disc. due to unsol final resp` The protocol received a response that had the Final bit set even though the last command sent by the protocol did not have the Poll bit set.

The following status messages are used by the protocol to return data in response to a control write:

88	ST25L2STAT	`Statistics upload` This message is sent in response to a `CW_STATS` control write. The data buffer contains a `x25l2stat_type` structure (defined in `zcomx25.h`).

89	ST25REVCD	Revision code upload

This message is sent in response to a CW_REVCODE control write. The data buffer contains a single byte which is the current protocol version. Currently, this is 11.

Write Completion Status Codes

The following statuses are returned in response to write requests. Although these are a part of the standard status set, they are not used by all protocols, and have a particular significance within this protocol.

0	IO_OK	No error detected

The request was successfully transmitted and acknowledged by the remote side.

1	IO_DSBL	Terminal disabled

The terminal must be enabled before it will accept write or control write requests.

22	IO_LNK_DSC	Link disconnected

An unrecoverable error occurred while this request was waiting to be sent or to be acknowledged by the remote side. The transmit request has been flushed.

23	IO_LNK_RST†	Link reset

A recoverable error occurred while this request was waiting to be acknowledged by the remote side. The transmit request has been flushed.

Control Write Completion Status Codes

The following statuses are returned in response to control write requests. Although these are a part of the standard status set, they are not used by all protocols, and have a particular significance within this protocol.

0	IO_OK	No error detected

The request was successfully transmitted and acknowledged by the remote side.

1	IO_DSBL	Terminal disabled The terminal must be enabled before it will accept write or control write requests.
11	IO_LONG_MSG	Message too long Indicates one of the following errors: • The packet length in the header is not zero. • The control length in the header is not zero for a CW_STATS or CW_REVCODE request. • The control length in the header is greater than six for a CW_TIMERS request.
12	IO_SHRT_MSG	Message too short Indicates one of the following errors: • The request length is less than four (too short to contain the control write header). • The control length in the header is less than six for a CW_TIMERS request.
24	IO_BAD_CTL	Bad control function or format Indicates one of the following errors: • The control length in the header does not equal the request length plus four. • The control code in the header contains a value other than CW_STATS, CW_REVCODE or CW_TIMERS. • The value specified for a timer resolution in a CW_TIMERS request is outside of the range zero to four.

Read Completion Status Codes

All receive completion messages will have the status IO_OK. Received messages that have errors are not returned by the protocol.

4 Protocol Specific Configuration

Introduction

This section provides specific information on preparing the network configuration file when HDLC/LAP-D is to be used.The parts of the network configuration answer file relevant to HDLC/LAP-D are:

- Interface-Definition
- Port-Definition
- Subchannel-Definition
- Terminal-Definition

Interface-Definition

An ACC Interface-Definition line appears in the configuration file for each ACC card that will have LAP-D connections configured on it.

A sample Interface-Definition is as follows:

```
Z7300A 00   0:8      /opt/acc/z7300a/lapd.zabs
Z7300A 01   0:16     /opt/acc/z7300a/lapd.zabs
```

Port-Definition

The ports used must be defined. The definition is dependent upon the ACC card and interface that is being used.

A sample Port-Definition for the 4-channel T1/E1 card using the E1 interface with BNC connectors is as follows:

```
Port 01:4 E1BNC  Int DF HDB3
```

Refer to the *ACC Utilities Reference Guide* section on ttgen for details.

Subchannel-Definition

This field is for cards that support subchannels.

A sample Subchannel-Definition for the 4-channel T1/E1 card using eight timeslots is as follows:

```
Subch 01:4:01 HDLC INV=off ITBS=2 ts:01:FFh ts:02:FFh ~
ts:03:FFh ts:04:FFh ts:05:FFh ts:06:FFh ts:07:FFh ts:08:FFh
```

Refer to the *ACC Utilities Reference Guide* section on ttgen for details.

Terminal-Definition

Each HDLC/LAP-D Mux channel requires one (and only one) Terminal-Definition for the HDLC/LAP-D point-to-point link. The LAP-D terminal is defined by a Terminal-Definition line in the ZCOM network answer file (*-.answ*).

Some sample HDLC/LAP-D Terminal-Definition lines for the Z7300A card follow:

```
Term  120    1:6:3 LAPD.DLE     HDLC_DTE_400MS     1030 0 0 0 0 “HDLC link 1”
Option 0000h 0008h
Term  120    1:6:3 LAPD.DLE     8080H 146AH        1030 0 0 0 0 “HDLC link 1”
Option 0000h 0008h
```

The first example above is a Terminal-Definition that defines an HDLC/LAP-D terminal with ZLU 120 on card 1 port 6 subchannel 3. It is configured as a DTE (user side) with frame time-out value of 400 milliseconds. The first OPTION word configures the idle line timer to the default value. The second OPTION word defines the SAPI and TEI. The second definition is the same as the first except that it uses the POLL and SELECT words to define the mode of operation. When the POLL and SELECT values are used they are specified as two 16 bit hex values.

NOTE This is “non-standard” hexadecimal notation.

The descriptions of the fields within these values are described below under Poll/Select/Option Configuration Values.

The Terminal-Definition takes the following format:

```
Term  zlu  mux:port:subc dtype poll select
             appl_no inst_no brch_no wkst_no area_no name <option>
```

More specific information on the parameters in the HDLC/LAP-D Terminal-Definition follows.

ZLU — This number (120 in the example) assigns a unique reference number for this terminal.

mux:port:subc	The port assigned must be configured as above and the ACC card must have the appropriate HDLC/LAP-D firmware configured. You must also have defined the subchannel number in the Subchannel definition section.
dtype	The device type of the HDLC/LAP-D terminal must be LAPD.DLE.
poll/select	This supplies the "POLL" and "SELECT" parameters for the ZCOM Terminal-Definition. These are used to specify: • whether the HDLC/LAP-D terminal acts as a DTE (user side) or DCE (network side), • the frame re-transmission time-out value, • the re-transmission count limit, • the outstanding frame window size to be used, and • the maximum frame size allowed. In most cases a pre-configured keyword will suffice. For the list of currently predefined keywords, see "Predefined Configuration Values" section of this chapter. If a different set of values is required, then different values for the "POLL" and "SELECT" codes may be entered here in the standard poll and select format in hexadecimal. For the format of these words, see "Poll/Select/Option Configuration Values" on page 46.
appl_no	Application number (Application dependent - has no effect on protocol).
inst_no	Institution number (Application dependent - has no effect on protocol).
brch_no	Branch number (Application dependent - has no effect on protocol).
wkst_no	Workstation number (Application dependent - has no effect on protocol).
area_no	Area number (Application dependent - has no effect on protocol). The five parameters above are for the use of the

application and can be set to any value desired. They can be accessed by the application from the Logical Terminal Table using ZINFO().

name — Choose a meaningful description of the LAP-D link, preferably including a reference to the location of the remote end of the link. This field will be used in some ZMNTR displays. It may also be accessed programmatically using the ZINFO call.

options — This configuration keyword supplies the “OPTION” parameters for the ZCOM Terminal-Definition. These are used to specify:

- the idle line time-out value,
- outstanding frame window sizes larger than seven, and
- the SAPI and TEI.

Predefined Configuration Values

The following configuration values are currently defined for use in HDLC/LAP-D configuration as a replacement for the POLL and SELECT address fields. These values are used (for example HDLC_DTE_3.0) as a symbolic way of configuring the associated two 16-bit hexadecimal values.

If a particular desired configuration value is not provided by these values, then two hexadecimal values can be used instead (as for normal poll and select specification).

```
HDLC_DTE_400MS   and   HDLC_DCE_400MS

     N201 = 0128 bytes
          T200 = 400ms    K = 3     N200 = 10
    Equivalent parameters
     HDLC_DTE_400MS - 8080h 146Ah
     HDLC_DCE_400MS - 0080h 146Ah
HDLC_DTE_3.0   and   HDLC_DCE_3.0

          N201 = 1024 bytes
          T200 = 3.0sec   K = 3,    N200 = 10

    Equivalent parameters
     HDLC_DTE_3.0   - 8400h 4F6Ah
     HDLC_DCE_3.0   - 0400h 4F6Ah
```

Note that specific user defined configurations may be added to the ttgen configuration file. These should use the **#define** statement and be placed at the beginning of the file. Refer to the examples in the file /opt/acc/cfg/ttgendefine.

CAUTION

DO NOT make changes to the /opt/acc/cfg/ttgendefine file itself, since this is part of the ACC Base product software, and may be overwritten when updates to the product are applied.

Poll/Select/Option Configuration Values

The following parameters for configurable for HDLC/LAP-D links:

SAPI	The Service Access Point Identifier
TEI	The Terminal Endpoint Identifier
U/N	Operating mode - User or Network side
K	Number of outstanding I frames
N200	Number of retransmissions allowed
N201	Largest I-field allowed (in bytes)
T200	Acknowledgment Timer
T203	Idle line Timer
UI	Unnumbered Information terminal

T200 and T203 are configured by selecting a value (Val) and a resolution (Res). Val can range from 1 to 31 and Res selects either 10 msec, 100 msec, 1 sec or 10 sec resolution. For a given Val and Res, the configured value is (2*Val Res). The actual timeout period however, may occur up to one Res before the configured value. The following table shows the minimum and maximum timeouts for various combinations of Res and Val.

Val	Res	Minimum Timeout	Maximum Timeout
1	10 msec	10 msec	20 msec
2	10 msec	30 msec	40 msec
31	10 msec	610 msec	620 msec
1	100 msec	100 msec	200 msec
4	100 msec	300 msec	400 msec
31	100 msec	6100 msec	6200 msec
1	1 sec	1 sec	2 sec
8	1 sec	15 sec	16 sec
31	1 sec	61 sec	62 sec
1	10 sec	10 sec	20 sec
16	10 sec	310 sec	320 sec
31	10 sec	610 sec	620 sec

When choosing values for timers, it is preferable to choose the resolution that has the longest interval but is still suitable for your application.

Poll Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
U/N	UI	N201 (1-16383 bytes) See note below													

U/N — Configure port as user or network side:
0 = Port to act as network side
1 = Port to act as user side

UI — Configure terminal as a UI (Unnumbered Information) terminal:
0 = Terminal is not a UI terminal
1 = Terminal is a UI terminal

N201 — Maximum number of bytes in the largest acceptable I field. Values from 1 to 16,383.

Select Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
T200 Res		T200 Val (I-63)						K (0-7)			N200 (1-31)				

T200 Val — This is the value of the T200 Acknowledgment timer divided by two. The valid range for this field is 1 to 63 which translates to T200 timer values of 2 to 126. 0 is not allowed and is an error. The units of this timer are given by the T200 Res (resolution) field (see below). Before configuring T200, you should read the description of timer configuration at the beginning of this section.

T200 Res — Resolution of T200 Val above. The values correspond as follows:

0 = 10 milliseconds
1 = 100 milliseconds
2 = 1 second
3 = 10 seconds

K — Level 2 window size, values 1 to 7. Note that if 0 supplied, the LargeK value in the first option word is used. It is an error if both K and LargeK are 0.

N200 — Number of retransmissions, values 1 to 31. Note that 0 is not allowed and is an error.

First Option Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
T203 Res		T203/2 Val (0-63)						IUF	LargeK (0-127)						

T203 Val — This is the value of the T203 Idle line timer divided by two. Setting this field from 1 to 63 translates to T203 timer values of 2 to 126. The units of this timer are given by the T203 Res (resolution) field (see below). If a value of zero is given for both this field and T203 Res, a default value of approximately T200*N200*100/16 will be used for a user-side terminal. (The default for a network-side terminal is T203 disabled.) If T203 Res is non-zero but this field is zero, T203 will be disabled. Before configuring T200, you should read the description of timer configuration at the beginning of this section.

T203 Res — Resolution of T203 Val above. The values correspond as follows:

0 = 10 milliseconds
1 = 100 milliseconds
2 = 1 second
3 = 10 second

IUF — Error handling, normal when 0. This means normal error handling (level 2 link reset) on receipt of unsolicited response frame with F=1. 1 means Ignore F=1 (treat as F=0) in any unsolicited response frames.

LargeK — Level 2 window size, values 1 to 127. LargeK is only used if K in the Select Word is 0. It is an error if both K and LargeK are 0.

Second Option Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0		SAPI						0	TEI						

0	Unused - should always be zero.
SAPI	The Service Access Point Identifier.
TEI	This value is used as the Terminal Endpoint Identifier.

A Sample Configuration Files

Sample Network Configuration File

The file shown below is the sample network configuration file that is provided with the HDLC/LAP-D protocol product.

```
#include "/opt/acc/cfg/ttgendefine"
ttgen
   Configuration
      system-name          "ACC LAPD protocol ttgen input file"
      program-zlu          100
      terminal-zlu         1000
      logical-term         800
      physical-term        800
      buffer-pool          3000000
      logical-size         252
      queue-Limit          9999
      transmit-limit       100
      unack-limit          5000
      port-limit           20000
      E1T1-Port-Limit      100000
      node-entry                1

  Interface-Definition

      z7300a   0       10:16:16   /opt/acc/z7300a/lapd.zabs

  Port-Definition

               Port 0:0 E1RJ45 Int CRCMF HDB3
               Port 0:1 E1RJ45 Ext CRCMF HDB3
               Port 0:2 E1RJ45 Int CRCMF HDB3
               Port 0:3 E1RJ45 Ext CRCMF HDB3

  Subchannel-Definition

*              Mux 0, port 0, subchan 01, timeslot 1
               Subch 0:0:01 HDLC INV=off ITBS=2 ~
                 ts:01:FFh

*              Mux 0, port 0, subchan 02, timeslot 2 to 7
               Subch 0:0:02 HDLC INV=off ITBS=12 ~
                 ts:02:FFh ts:03:FFh ts:04:FFh ts:05:FFh ts:06:FFh ts:07:FFh

*              Mux 0, port 0, subchan 03, timeslot 8 to 31
               Subch 0:0:03 HDLC INV=off ITBS=48 ~

                 ts:08:FFh ts:09:FFh ts:10:FFh ts:11:FFh ts:12:FFh ~
                 ts:13:FFh ts:14:FFh ts:15:FFh ts:16:FFh ts:17:FFh ~
```

```
                ts:18:FFh ts:19:FFh ts:20:FFh ts:21:FFh ts:22:FFh ~
                ts:23:FFh ts:24:FFh ts:25:FFh ts:26:FFh ts:27:FFh ~
                ts:28:FFh ts:29:FFh ts:30:FFh ts:31:FFh

*             Mux 0, port 1, subchan 01, timeslot 1
              Subch 0:1:01 HDLC INV=off ITBS=2 ~
                ts:01:FFh

*             Mux 0, port 1, subchan 02, timeslot 2 to 7
              Subch 0:1:02 HDLC INV=off ITBS=12 ~
                ts:02:FFh ts:03:FFh ts:04:FFh ts:05:FFh ts:06:FFh
                ts:07:FFh

*             Mux 0, port 1, subchan 03, timeslot 8 to 31
              Subch 0:1:03 HDLC INV=off ITBS=48 ~
                ts:08:FFh ts:09:FFh ts:10:FFh ts:11:FFh ts:12:FFh ~
                ts:13:FFh ts:14:FFh ts:15:FFh ts:16:FFh ts:17:FFh ~
                ts:18:FFh ts:19:FFh ts:20:FFh ts:21:FFh ts:22:FFh ~
                ts:23:FFh ts:24:FFh ts:25:FFh ts:26:FFh ts:27:FFh ~
                ts:28:FFh ts:29:FFh ts:30:FFh ts:31:FFh

  Terminal-Definition

      Term 600 0:0:01 LAPD.DLE 1000h 46EAh 90 601 1 0 0 "LAP-D DCE"
               option 0086h 0001h
      Term 601 0:1:01 LAPD.DLE 9000h 46EAh 90 600 2 0 0 "LAP-D DTE"
               option 0086h 0001h
      Term 602 0:0:02 LAPD.DLE 1000h 46EAh 90 603 1 0 0 "LAP-D DCE"
               option 0086h 0001h
      Term 603 0:1:02 LAPD.DLE 9000h 46EAh 90 602 2 0 0 "LAP-D DTE"
               option 0086h 0001h
      Term 604 0:0:03 LAPD.DLE 1000h 46EAh 90 605 1 0 0 "LAP-D DCE"
               option 0086h 0001h
      Term 605 0:1:03 LAPD.DLE 9000h 46EAh 90 604 2 0 0 "LAP-D DTE"
               option 0086h 0001h
             Node-Definition
           Local-Node     123

      End$
```